CONODONTS FROM THE UPPER PERMIAN STRATA OF NOTTINGHAMSHIRE AND NORTH YORKSHIRE

by A. SWIFT *and* R. J. ALDRIDGE

ABSTRACT. Conodont elements have been found in samples of Upper Permian age from three separate areas in Nottinghamshire and North Yorkshire. The collections from Nottinghamshire comprise specimens derived from older rocks; in one area the source was of Carboniferous age, in the other it was Devonian. Collections from North Yorkshire appear to be largely indigenous and contain the zonal conodont *Merrillina divergens* (Bender and Stoppel) and elements of *Ellisonia*. These are the first identifiable Permian conodonts recorded from Britain.

CONODONTS from the British Permian are almost unknown. The only published record is of a single indeterminate fragment from the lower subdivision of the Lower Magnesian Limestone (Zechstein 1) of the Aiskew Bank Farm borehole, North Yorkshire (Pattison 1978, p. 5, fig. 6). Conodonts have been reported from other Zechstein 1 deposits of Germany by Bischoff and Ziegler (1957), Malzahn (1957), and Seidel (1959), but not until the landmark paper of Bender and Stoppel (1965) were German Zechstein 1 conodonts described systematically. Jordan (1969) also contributed a short paper on German Zechstein 1 conodonts, and Szaniawski (1969) recorded the first Zechstein 1 conodonts from Poland, but knowledge of north-west European Upper Permian faunas is still limited. Elsewhere, recent research has greatly increased the information available on Upper Permian conodonts. Much of this literature has originated from North America, where Sweet (i.a. 1970*a*, *b*, 1973, 1976), Clark and Behnken (1971), Behnken (1975), and Wardlaw and Collinson (1979*a*, *b*) have all made significant contributions. In Europe a large number of papers have been published by Kozur (e.g. 1975, 1977, 1978), alone or with co-authors, that cover a wide range of Permian and Triassic morphological and biostratigraphical topics.

In this report we record the first identifiable conodonts from British Permian strata. All our samples are from the first transgressive phase of the Zechstein Sea (Zechstein 1), represented by the Lower Magnesian Limestone and the Permian Lower Marl. Our stratigraphical nomenclature follows Smith *et al.* (1974).

SAMPLE LOCALITIES

Locality numbering follows the system employed in the Micropalaeontology Unit, Geology Department, Nottingham University. The distribution of localities is shown in text-fig. 1, and the microfossil assemblages recovered by acetic acid digestion are listed in Table 1.

North Yorkshire

Loc. 283. Lower Magnesian Limestone. The Aiskew Bank Farm borehole drilled by the Institute of Geological Sciences, 800 m north of Bedale centre (Pattison 1978); SE 2667 8888. Five samples of grey-brown, fine-grained dolomite from the following depth intervals: 69–74 m, 74–79 m (both from upper subdivision), and 79–84 m, 84–89 m, 89.0–92.2 m (all from lower subdivision). The base of the Permian was encountered at 96.45 m.

Loc. 284. Lower Magnesian Limestone. The Sand Hutton borehole drilled by the National Coal Board, 3 km west of Thirsk station; SE 3789 8157. Five samples of grey-brown, fine-grained dolomite from the

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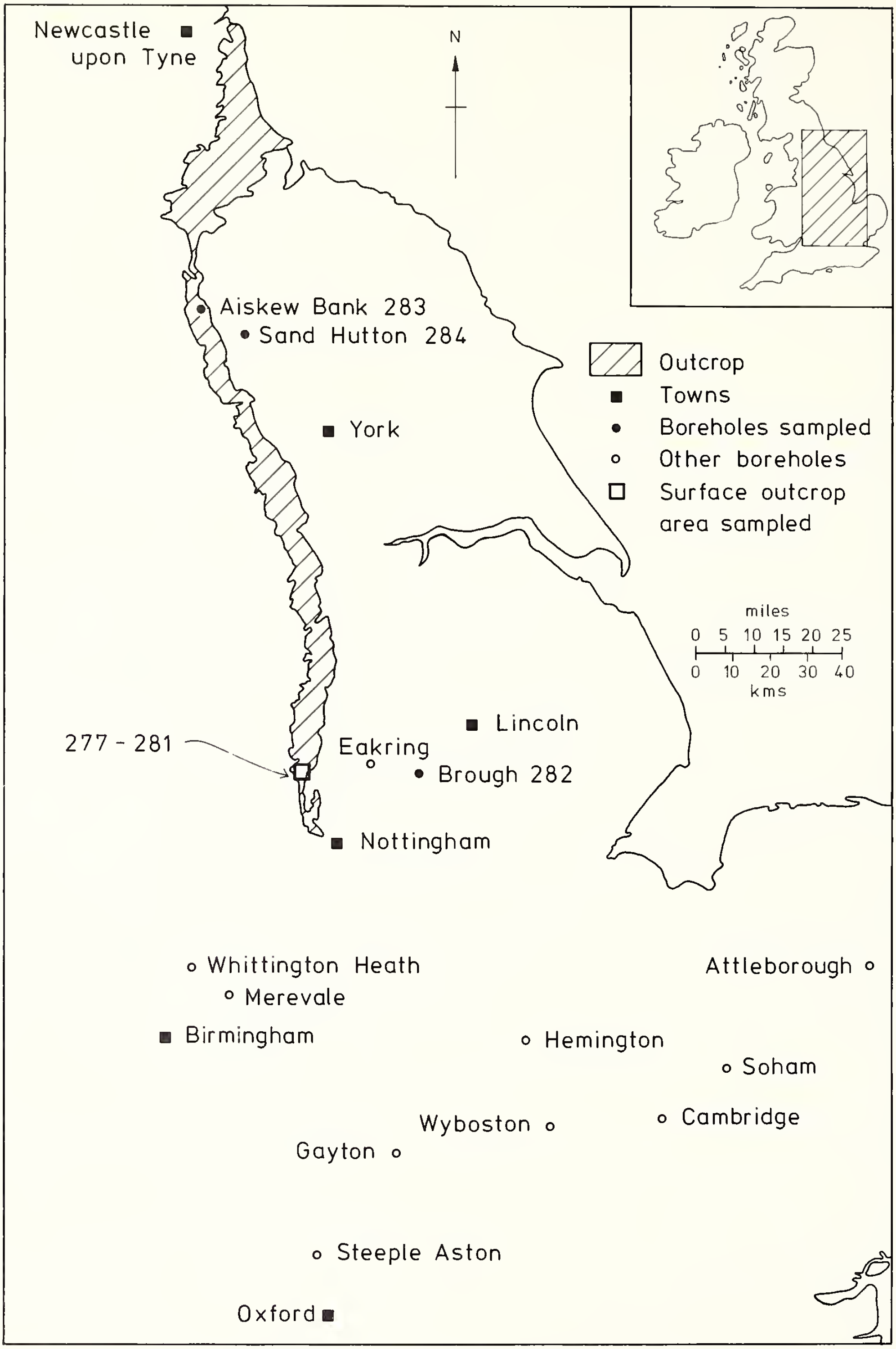

TEXT-FIG. 1. Upper Permian surface and borehole sample localities. Other boreholes are shown that penetrated Devonian strata. The outcrop of Magnesian Limestone and Permian mudstones is shown (after Geological Map of the U.K., 3rd edition 1979, Institute of Geological Sciences).

following depth intervals: 349.5–354.6 m, 355.8–367.9 m, 364.0–369.0 m, 381.75–384.75 m, and 385.0–386.64 m. The base of the Permian was encountered at 386.67 m.

Nottinghamshire

Loc. 277. Lower Magnesian Limestone. Abandoned railway cutting immediately west of Studfold (Smith, Rhys and Eden 1967); SK 499 556. Six samples of red, shelly, crystalline limestone.

Loc. 278. Permian Lower Marl. Road cutting in Teversal, immediately east of the railway bridge on the road to Fackley (Smith, Rhys and Eden 1967); SK 480 618. Five samples of very shelly, thin-bedded limestone.

Loc. 279. Lower Magnesian Limestone. Small excavation behind houses in Stony Houghton; SK 4925 6623. Five samples of grey and red carbonate, possibly dedolomite.

Loc. 280. Lower Magnesian Limestone. Railway cutting 450 m east of Teversal Colliery, at milepost 142; SK 4792 6204. One sample of blue-hearted, brown dolomite.

Loc. 281. Lower Magnesian Limestone. Hillside exposure on Herrod's Hill, 375 m north of Huthwaite Market Place; SK 4680 6015. One sample of yellow dolomite.

Loc. 282. Permian Lower Marl. The Brough borehole, drilled by the National Coal Board in 1980 near Collingham, 325 m south-south-west of Glebe Farm; SK 8335 5840. One sample from a depth of 557 m of medium-grained, poorly calcareous sandstone.

SAMPLE NUMBER	WEIGHT (g)	CONODONTS	OTHER MICROFAUNA				
			F	O	H.S.	F.M.	S
277/1	1890	23	×			×	
-/2	2035	36				×	
-/3	1814	10				×	
-/4	1510	19	×			×	
-/5	1644	6			×	×	
-/6	1964	4	×			×	
278/1	2000	1	×		×	×	
-/2	1990	0	×		×	×	
-/3	2000	0	×			×	
-/4	1500	0	×			×	
-/5	1519	13	×			×	
279/1	2300	2	×			×	
-/2	2000	1	×				
-/3	1590	0					
-/4	2100	1				×	
-/5	1663	11				×	
280/1	1757	0	×				
281/1	1853	0	×			×	
282/1	2240	90	×			×	
283/1	3413	35	×		×	×	
-/2	2000	5	×		×	×	
-/3	2000	4	×		×	×	×
-/4	1900	31	×	×	×	×	
-/5	2000	2	×		×	×	
284/1	2000	3			×		
-/2	1654	4	×		×	×	×
-/3	1227	3	×		×	×	×
-/4	1531	0	×		×	×	
-/5	1744	0	×	×	×	×	

TABLE 1. Sample weights, conodont numbers, and distribution of other microfossils. F = foraminifera; O = ostracods; H.S. = holothurian sclerites; F.M. = fish microdebris; S = scolecodonts.

THE CONODONT ASSEMBLAGES AND THEIR SIGNIFICANCE

North Yorkshire, localities 283 and 284

The majority of the conodonts recovered from the North Yorkshire boreholes are demonstrably of Permian age, and our collections compare most closely with the faunas reported from Zechstein 1 deposits of north-west Europe.

A few elements in our material also resemble forms reported from Kashmir, Pakistan, and Greenland (Sweet 1970*a*, *b*, 1976), and North America. Diversity and numbers are low; most of the elements can be referred to apparatuses assigned to the genus *Ellisonia*. Identifications are given in Table 2.

Although we suspect the nature of the multi-element relationships of the majority of our specimens, our collections are too small to enable us to establish accurate apparatus reconstructions or to evaluate those proposed by other authors. Some specimens compare with described forms: for example, one Sc element (Pl. 90, figs. 5–7) is similar to the form named *Hindeodella triassica* by Müller (1956, p. 826, figs. 4, 5) and two of our M elements (Pl. 90, figs. 9, 14) may be close to *Lonchodina inflata* Bender and Stoppel (1965, p. 346, pl. 15, fig. 8) and *L. festiva* Bender and Stoppel (1965, p. 345, pl. 15, fig. 10) respectively. Our collections also contain probable

CONODONTS / SAMPLE NUMBER	LOC. 283					LOC. 284		
	1	2	3	4	5	1	2	3
Ellisonia cf E. triassica Prioniodinan element			1					1?
Ellisonia spp. Pb? elements	3							
M elements				5				
Sa elements	4							
Sa/Sb elements	1							
Sb elements	1							
Sc elements	3		1	4		1	1	
Fragments	12	1	1	11	1	1	3	
Merrillina divergens P element				4				
Indeterminate P element					1			
Gen. et sp. indet.	1	4	1	7		1		2

TABLE 2. Conodonts recovered from the North Yorkshire borehole samples. Samples 284/4 and 284/5 failed to yield conodonts. Multi-element notation follows Sweet and Schönlaub (1975).

representatives of two form-species erected by Szaniawski (1969); an Sa element (Pl. 90, fig. 8) compares with *Hibbardella baltica* Szaniawski (1969, p. 332, pl. 2, figs. 11, 12), and a Pb? element (Pl. 90, fig. 3) is similar to *Prioniodina lindstroemi* Szaniawski (1969, p. 332, pl. 2, figs. 6–9). A prioniodinan (Pb?) element included by Sweet (1970*a*, pl. 1, fig. 19) in multi-element *Ellisonia triassica* may also be represented (Pl. 90, fig. 4), but we do not have other robust elements with inverted cavities that are considered to be characteristic of this apparatus (Sweet 1970*b*, p. 235). However, many of our specimens could be accommodated in apparatuses of similar structure to those assigned to various species of *Ellisonia* (Sweet 1970*b*, pp. 224–239, pls. 4, 5). Some of the form-species present in our collections, first described by Bender and Stoppel (1965) and Szaniawski (1969), have been included in the multi-element genus *Stepanovites* by Kozur (1975, pp. 22–27), but we find it difficult to assess the relationships between this genus and *Ellisonia*, and, for the present, refer to our material under the older name.

Our collections also include a few specimens (Pl. 90, figs. 1, 2) of *Merrillina divergens* (Bender and Stoppel). In erecting the genus *Merrillina*, Kozur (1975, p. 21) noted that it was difficult to determine which ramiform elements were combined with the characteristic spathognathodontan elements; it seems likely that most of the elements here included in *Ellisonia* belong in the same apparatus as *Merrillina*. Solution of these taxonomic and nomenclatural problems awaits the study of large, well-preserved collections.

M. divergens has been reported from north-west European Zechstein 1 sediments (Bender and Stoppel 1965; Jordan 1969; Szaniawski 1969), and from the Upper Permian of North America (Clark and Behnken 1971; Behnken 1975; Wardlaw and Collinson 1979*a*, *b*). In America the species has proved to be of biostratigraphical value; Clark and Behnken (1971) recognized a '*Neospathodus divergens* Fauna' in the upper part of the Capitanian (upper Guadalupian) of Nevada, where Behnken (1975, p. 293) subsequently delimited a *Neogondolella rosenkrantzi–Neospathodus divergens* Assemblage zone with a base marked by the appearance of *N.* (= *Merrillina*) *divergens*. Wardlaw and Collinson (1979*b*) followed Clark and Behnken (1971) in recognizing a *M. divergens* Zone within the Guadalupian throughout the Great Basin and Rocky Mountain regions of the western United States. There is, however, some dispute as to whether the North American specimens are conspecific with *M. divergens*. Kozur and Mostler (1976, p. 11, pl. 1, fig. 8) refigured the specimen illustrated by Clark and Behnken (1971, pl. 2, fig. 6) as the holotype of new species, *M. praedivergens*, which they considered to be the stratigraphical antecedent of *M. divergens*. In his proposals for a new standard chronostratigraphy for the Permian System, Kozur (1977) placed the Capitanian stage at the top of the Middle Permian and (Kozur 1978) defined a '*Gondolella bitteri–Stepanovites meyeni–Merrillina praedivergens* Assemblage Zone' that spanned the stage. *M. divergens* was confined to his succeeding Abadehian Stage at the base of the Upper Permian, where a '*Gondolella bitteri–Stepanovites inflatus–Merrillina divergens* Assemblage Zone' could be recognized in Iran, Europe, and Greenland. We remain wary of accepting this biostratigraphic scheme until the faunal sequences have been demonstrated in a single area. Within the Zechstein area, however, our recovery of *M. divergens* corroborates the established correlation of the Lower Magnesian Limestone with the Zechsteinkalk (Smith *et al.* 1974).

Nottinghamshire localities 277–281

Conodonts were recovered from samples from localities 277, 278, and 279. Numbers are small and the specimens are mostly fragmentary, ranging from 0.125 mm to 0.35 mm in size. The majority are too broken to allow identification, but a few are sufficiently well preserved for generic, and in some cases possible specific, assignments to be suggested.

Most of the identifiable specimens compare closely with elements of known Carboniferous species. For example, one specimen of an M element (Pl. 91, fig. 5) is very similar to illustrated specimens of the form-species *Neoprioniodus singularis* (Hass), a common constituent of British Viséan and Namurian faunas (Rhodes, Austin and Druce 1969, p. 160; Higgins 1975, p. 68). The form *Metalonchodina bidentata* (Gunnell) is probably represented in our material by a single broken specimen (Pl. 91, fig. 1) with a prominent cusp, and large adjacent laterally compressed denticle diverging from it at an angle of 22°. Again, this is known from the British Viséan and Namurian, as is *Spathognathodus campbelli* Rexroad, with which we compare one Pa element (Pl. 91, fig. 2) on the basis of general morphological similarity and, particularly, the presence of a dark longitudinal stripe in the blade. Fragments of platform elements are rare in our collections, and only one allows a suggested identification. This specimen (Pl. 91, fig. 10) displays part of the blade and inner lateral parapet of a dextral element comparable with specimens referred to the Carboniferous genus *Cavusgnathus*. Specific assignment is not possible, but the blade is unusual for British representatives of *Cavusgnathus* in that the denticles decrease in height posteriorly. Species reported from Britain show an increase in denticle height posteriorly, the blade terminating in a prominent cusp, as, for example, in *C. regularis* Youngquist and Miller and *C. naviculus* (Hinde) (see Higgins 1975, pl. 8, figs. 1–5, 12, 13). Other specimens (Pl. 91, figs. 3, 4, 6–8) are too broken for specific determination, but all have their morphological counterparts in Carboniferous faunas. An exception is an ozarkodinan element (Pl. 91, fig. 9), which does not compare in detail with any described Carboniferous or Permian form.

It is evident that these collections represent conodonts derived from Carboniferous strata exposed at the time of the late Permian marine transgression. The source appears to have been of Viséan or Namurian age as conodonts recovered from local Westphalian marine bands show little similarity to our remanie material.

Nottinghamshire locality 282

Conodonts from the Brough borehole are broken and abraded, some being sub-rounded. Only a few are identifiable and those showing the best preservation are illustrated (Pl. 91, figs. 11–19). Several are fragments of platform elements, which are unlike those of Permian genera and indicate a Devonian source.

The most significant components of the collection are platform elements of *Polygnathus* and *Icriodus*. *Polygnathus* occurs in Devonian and Carboniferous faunas, but *Icriodus* is restricted to the Devonian. Our specimens of *Icriodus* clearly exhibit three rows of nodes on the platform and a large basal cavity occupying the entire lower surface. A coniform element from the same sample (Pl. 91, fig. 11) may also belong to *Icriodus*. Other ramiform specimens (Pl. 91, figs. 14, 15) are not diagnostic of a Devonian age, but elements of comparable morphology are common in Devonian faunas.

Strata of Carboniferous age occur widely in the area around Nottinghamshire, and provide ready sources for the derived Carboniferous specimens found in north-west Nottinghamshire. The origin of these Devonian conodonts is more problematical. There is at present no outcrop of

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EXPLANATION OF PLATE 90

Figs. 1, 2. *Merrillina divergens* (Bender and Stoppel). 1, lateral view of MPK 3123, ×100. 2, lateral view of MPK 3124, ×100. Both specimens from 283/4.

Figs. 3, 5–15. *Ellisonia* spp. 3, inner lateral view of Pb? element MPK 3125, ×100, 283/1. 5–7, inner lateral views of Sc elements MPK 3127, MPK 3128, MPK 3129; all specimens ×60, 283/4. 8, lateral view of Sa element MPK 3130, ×100, 283/1. 9, 10, 14, inner lateral views of M elements MPK 3131, ×150; MPK 3132, ×150; MPK 3136, ×100. All specimens from 283/4. 11, inner lateral view of Sa/Sb element MPK 3133, ×100, 283/1. 12, 13, inner lateral views of Sc elements MPK 3134, ×100, 283/1; MPK 3135, ×150, 283/3. 15, inner lateral view of Sb element MPK 3137, ×150, 283/1.

Fig. 4. *Ellisonia* cf. *E. triassica* Müller, Prioniodinan element. Inner lateral view of MPK 3126, ×60, 283/3.

Fig. 16. Indeterminate P element. Upper view of MPK 3138, ×150, 283/5.

Repository of specimens on this plate: Institute of Geological Sciences, Ring Road, Halton, Leeds.

SWIFT and ALDRIDGE, Upper Permian conodonts marine Devonian rocks nearer than North Devon, but borehole evidence has demonstrated sub-surface marine Devonian strata beneath areas of south-east and south central England. Wills (1973) cited sub-surface occurrences of probable marine Devonian as far north as Gayton, Wyboston, Cambridge, Soham, and Attleborough (text-fig. 1). More recently, possible marginal marine Devonian sediments have been recovered from a borehole near Hemington, 40 km north-west of Cambridge (Allsop and Jones 1981). Possible marine Devonian strata have also been encountered at depth in the Whittington Heath (Mitchell 1954) and Merevale boreholes. Nearer our Brough locality, the Dukes Wood No. 146 borehole at Eakring (Lees and Taitt 1946) passed through conglomerates and sandstones of Old Red Sandstone facies and possible Devonian age (text-fig. 2A).

In many of the borehole sequences the Devonian deposits are succeeded by Carboniferous rocks, showing that they would not have been exposed during the Permian. Only at Wyboston, Hemington, Soham, and Attleborough does the Devonian directly underlie Mesozoic formations. Nowhere in this northern extension of the Devonian sea is there evidence of open marine faunas, whose nearest proven occurrence is in the Steeple Aston borehole of Oxfordshire (text-fig. 1), drilled by the Institute of Geological Sciences (Poole 1977). Macrofossils and microfossils there indicated a late Devonian age, and three samples of sandy limestone yielded on digestion conodont faunas characterized by *Polygnathus* and *Icriodus* (Reynolds, *in* Poole 1977), an association broadly similar to that present at Brough. Although the Devonian sequence in the Steeple Aston borehole is overlain by nearly 550 m of Upper Coal Measures and igneous intrusives, it does demonstrate that open marine conditions prevailed in this region in the late Devonian.

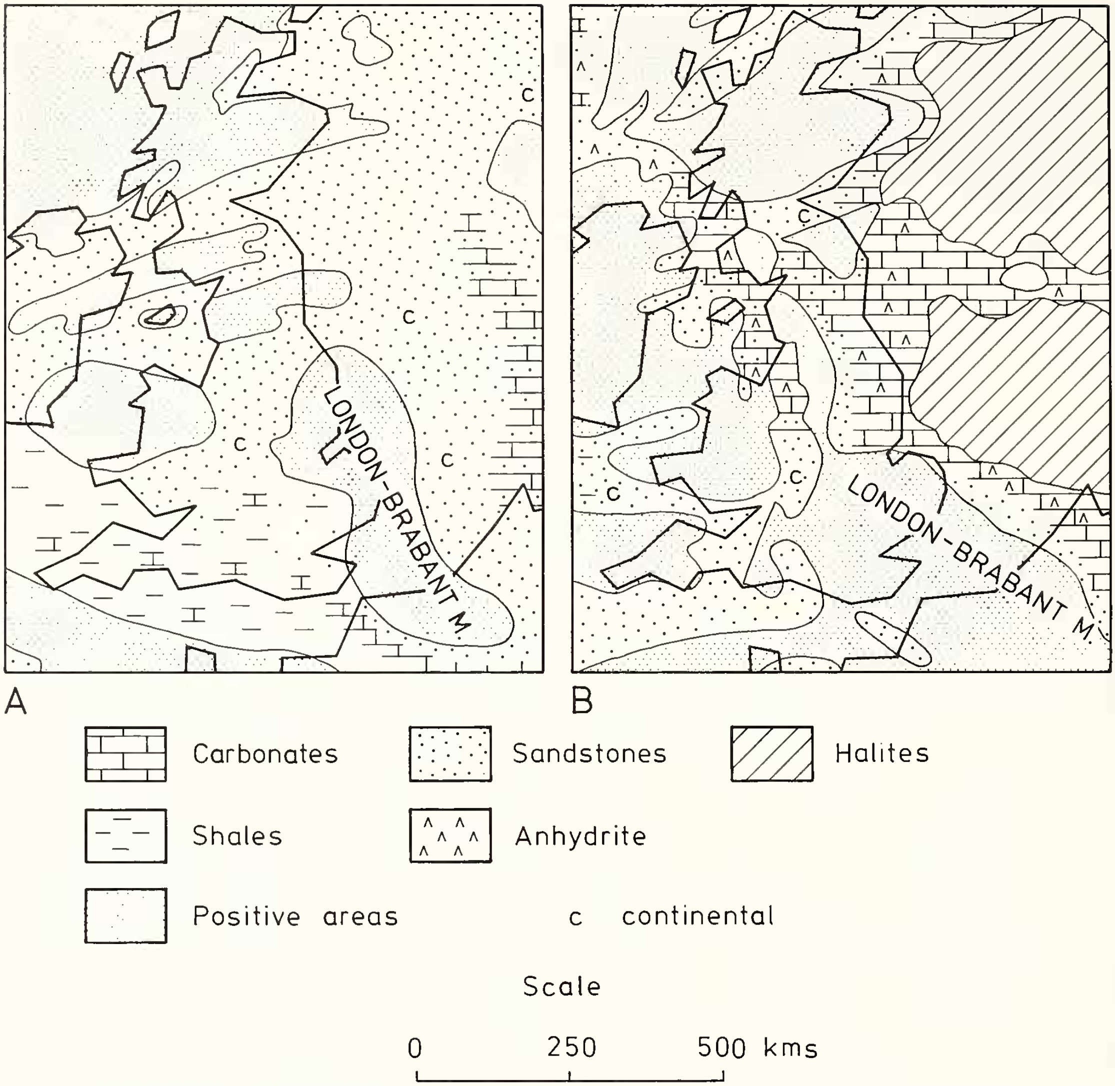
There is thus no evidence for a local source of our derived Devonian conodonts. It seems probable that they were carried into the Zechstein sea by fluviatile transport from Devonian outcrops at least some tens of kilometres to the south. The lack of any admixture of Carboniferous forms suggests that the transporting river did not cut any major Carboniferous outcrops, but presumably flowed over the Lower Palaeozoic and Precambrian basement that underlies much of the east Midlands (Wills 1973).

EXPLANATION OF PLATE 91

Fig. 1. *Metalonchodina* cf. *bidentata* (Gunnell). Inner lateral view of 3664/13, ×150, 277/5.
Fig. 2. *Spathognathodus*? cf. *S. campbelli* Rexroad. Lateral view of 3220/18, ×150, 277/1.
Figs. 3, 4. *Ozarkodina* sp. A. 3, lateral view of 3662/3, ×150, 277/2. 4, lateral view of 3661/0, ×150, 278/5.
Fig. 5. *Neoprioniodus* cf. *singularis* (Hass). Inner lateral view of 3662/2, ×150, 278/5.
Fig. 6. *Hindeodella* sp. Lateral view of 3665/15, ×100, 277/1.
Fig. 7. *Spathognathodus*? sp. Lateral view of 3664/12, ×150, 277/4.
Fig. 8. *Synprioniodina*? sp. Inner lateral view of 3661/1, ×150, 278/5.
Fig. 9. *Ozarkodina* sp. B. Lateral view of 3221/15, ×150, 278/5.
Fig. 10. *Cavusgnathus* sp. Inner lateral view of 3663/6, ×150, 277/2.
Fig. 11. Coniform element. Inner lateral view of 3985/9, ×150, 282/1.
Figs. 12, 13, 16. *Polygnathus* spp. 12, upper view of 3672/9, ×100. 13, upper view of 3669/41, ×150. 16, upper view of 3671/4, ×150. All specimens from 282/1.
Fig. 14. Ramiform element A. Inner lateral view of 3671/6, ×100, 282/1.
Fig. 15. Ramiform element B. Inner lateral view of 3670/1, ×150, 282/1.
Figs. 17–19. *Icriodus* spp. 17, upper view of 3671/7, ×100. 18, upper view of 3672/8, ×150. 19, upper view of 3670/3, ×150. All specimens from 282/1.

Repository of specimens on this plate: Conodont Reference Collection, Department of Geology, University of Nottingham.

SWIFT and ALDRIDGE, Upper Permian conodonts



TEXT-FIG. 2. Palaeogeographical maps of Britain during the late Devonian (A) and late Permian (B); after Ziegler (1981), with modifications.

CONCLUSIONS

Identifiable conodonts are shown for the first time to occur in the Upper Permian of Britain, although all the collections recovered are low in both numbers and diversity. Marginal deposits of the Zechstein basin (text-fig. 2B), such as those of Nottinghamshire, are more likely to contain conodonts redeposited from older strata than indigenous faunas. Our recovery of indigenous specimens from Zechstein 1 strata of North Yorkshire indicates that further investigations in the Yorkshire and Durham areas offer the best prospects of producing additional Permian faunas from Britain.

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